UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PLANT INDUSTRY
WESTERN IRRIGATION AGRICULTURE
WASHINGTON, D. C.

THE WORK OF THE HUNTLEY RECLAMATION PROJECT EXPERIMENT FARM IN 1917

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Irrigated Wheat in the Rotation Experiments at Huntley, Mont.

W. I. A. Circular 22 Issued September, 1918

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

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CONTENTS.

SCOPE OF THE EXPERIMENTAL WORK.

The work of the Huntley Experiment Farm is devoted mainly to experiments in the production and utilization of crops under irrigation. Experiments in dry-land agriculture are also conducted on a tract of land lying above the irrigation canal. The experiments with dry-land crops include crop rotation, tillage methods, and pasturing tests. This work is conducted by the Office of Dry-Land Agriculture. The work with irrigated crops includes crop rotations, tests of pasture grasses, pasturing experiments, cropping methods, and experiments with sugar beets, fruit trees, and small fruits. The arrangement of the fields and the locations of the principal experiments in 1917 are shown in figure 1.

Increasing attention has been given each year since the establishment of the farm to experiments intended to solve the problems connected with the establishment of live-stock industries on irrigated lands. These experiments include tests of pasture mixtures

[1] The Huntley Experiment Farm is located on the Huntley reclamation project, near the town site of Osborn, Mont. It comprises about 300 acres of public land, of which about 140 acres lie above the irrigation canal. The work of the farm is under the supervision of the Office of Western Irrigation Agriculture. The Office of Dry-Land Agriculture, the Biophysical Laboratory, and other offices of the Bureau of Plant Industry, the Dairy Division and the Animal Husbandry Division of the Bureau of Animal Industry, and the Montana Agricultural Experiment Station are cooperating in the investigational work.

and methods of establishing pastures, the production of crops for silage, and some work in pasture utilization. In 1917 rather extensive experiments with hogs were inaugurated, including the testing of varying quantities of grain as supplemental feed with alfalfa pasture and a comparison of different feeds in finishing hogs in a dry lot. Preparations were made for beginning in 1918 some experiments with dairy cattle, the necessary buildings and equipment to care for a herd of 20 cows having been provided. This work with live stock is conducted in cooperation with the Bureau of Animal Industry and the Montana Agricultural Experiment Station.

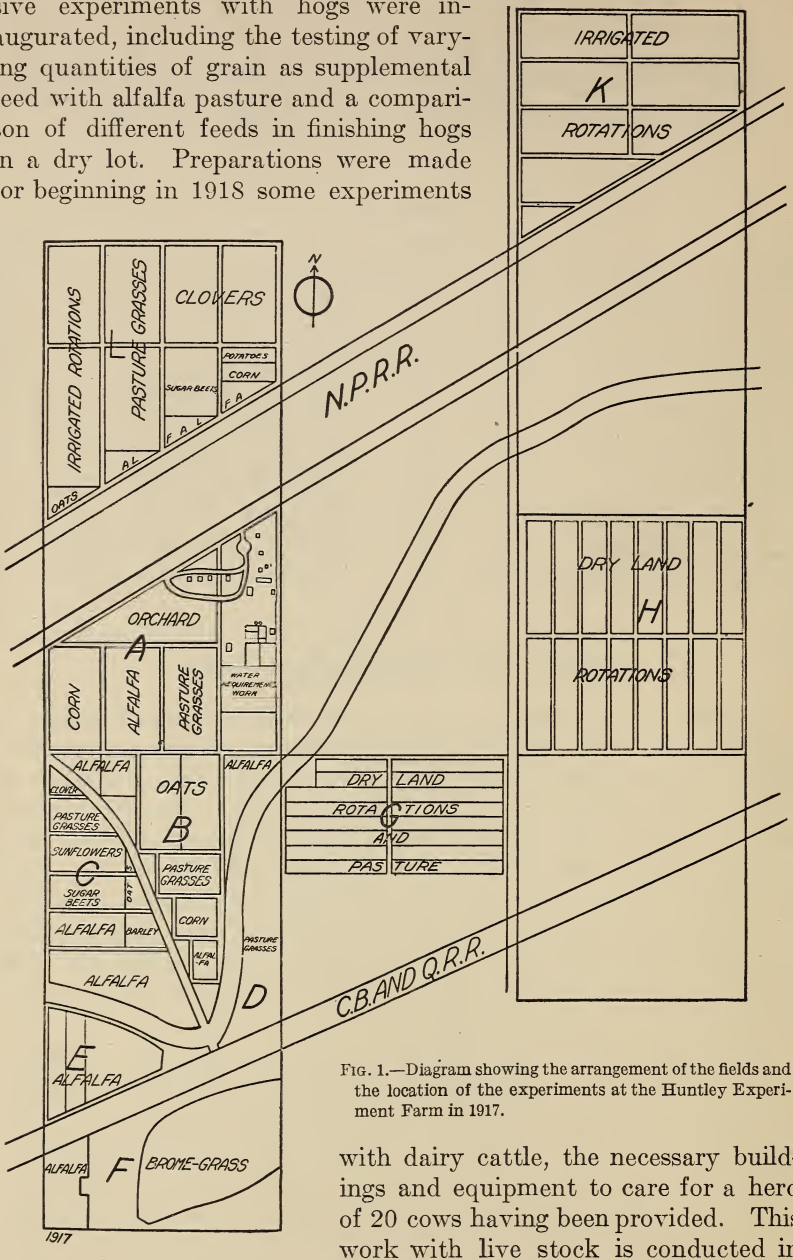

FIG. 1.—Diagram showing the arrangement of the fields and the location of the experiments at the Huntley Experiment Farm in 1917.

CONDITIONS ON THE PROJECT.

CLIMATIC CONDITIONS.

The total rainfall for the year 1917 was about normal and most of it occurred during the spring months. The amount of rainfall up to June 15 was 9.3 inches. During the month of July it was only 0.61 inch. The rainfall during the autumn months was also light, and severe freezing did not occur until early in December. The frost-free period was 119 days. The average for the past seven years is 125 days.

A summary of the climatological observations made at the Huntley Experiment Farm, 1911 to 1917, inclusive, is shown in Table I.[1]

TABLE I.—*Summary of climatological observations made at the Huntley Experiment Farm, 1911 to 1917, inclusive.*

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1911	0.64	0.32	0	0.85	3.29	2.13	0.81	1.05	0.57	0.88	0.82	0.13	11.49
1912	.27	.21	.41	2.00	2.44	1.14	2.25	1.39	2.97	3.25	.75	0	17.08
1913	.29	.10	.40	.43	1.27	2.20	1.10	1.19	1.43	2.89	.45	.17	11.92
1914	.11	.19	.52	1.16	2.93	3.31	.05	.76	1.90	1.07	.07	.24	12.21
1915	.41	.02	.78	.23	2.50	5.99	3.11	.50	1.64	.31	1.34	.71	17.54
1916	.46	.24	1.02	.89	1.81	2.11	1.50	.39	1.16	1.34	1.07	1.50	13.49
1917	.76	.49	1.41	1.01	2.88	2.75	.37	.24	.83	.75	.07	3.58	15.14
Average	.42	.22	.65	.94	2.45	2.80	1.31	.79	1.50	1.50	.65	.90	14.12

EVAPORATION (INCHES).

1911				4.388	5.827	7.124	8.875	6.071	5.079	2.568			39.932
1912					4.900	7.020	6.942	6.950	3.722	2.475			32.018
1913					4.300	5.080	7.020	6.300	4.450				28.050
1914				2.770	4.360	4.956	7.778	7.216	4.284				31.320
1915				4.170	4.304	4.582	5.493	6.018	3.348				27.915
1916				3.308	4.432	5.389	8.670	7.320	5.061				34.180
1917				2.069	3.854	6.216	8.086	6.913	4.321				31.459
Average				3.341	4.568	5.764	7.552	6.684	4.324	2.527			32.125

DAILY WIND VELOCITY (MILES PER HOUR).

Average:												
1911				5.6	5.6	4.5	4.6	4.4	4.4	4.2	5.4	5.5
1912	5.6	5.2	4.8	5.8	6.3	5.2	3.9	3.7	4.2	5.6	4.2	7.8
1913	6.3	5.9	5.2	6.3	4.5	3.8	3.7	3.2	3.6	4.0		
1914			5.3	5.1	4.0	3.2	2.7	3.2	3.5	2.5	3.5	2.5
1915	3.4	2.8	3.7	4.2	5.0	3.9	3.1	2.3	3.4	3.7	3.9	3.6
1916	5.2	4.6	5.2	4.7	5.9	4.9	3.8	3.4	4.0	4.4	6.6	5.9
1917	7.0	5.8	5.5	5.7	5.0	4.3	2.9	3.2	3.5	4.6	3.1	5.5
Maximum:												
1911				9.4	8.8	8.8	8.7	7.2	9.3	10.0	11.6	11.5
1912	12.8	10.8	12.1	13.0	17.5	7.7	6.0	6.5	8.0	14.7	9.7	14.6
1913	11.9	12.6	10.5	10.1	9.2	5.4	8.6	5.7	8.8	8.3		
1914			8.7	10.1	8.5	6.7	5.6	6.4	9.6	5.6	6.4	8.1
1915	7.3	5.8	8.4	10.0	16.2	6.1	6.6	4.5	8.4	9.0	10.6	8.4
1916	15.3	10.0	13.3	8.0	11.9	10.2	8.4	7.3	9.9	9.7	17.3	16.5
1917	16.5	14.1	12.9	17.8	9.2	7.7	4.1	5.9	7.3	8.0	8.4	26.6
Minimum:												
1911				2.0	1.5	2.7	2.3	2.1	1.0	1.3	1.4	1.5
1912	.7	1.6	.9	2.6	1.8	2.3	.6	.8	.9	1.5	1.0	2.7
1913	1.0	1.7	1.9	1.0	.9	1.3	2.1	.8	.4	1.5		
1914			1.6	2.1	1.7	1.6	.3	1.4	1.3	1.1	.8	.6
1915	.3	.8	.8	2.2	1.1	2.1	1.1	.4	1.0	1.2	1.2	1.0
1916	1.0	.9	1.5	2.9	2.7	1.5	1.9	.3	.9	1.8	.8	.4
1917	1.1	.9	.9	1.5	2.1	1.7	1.8	1.8	1.3	1.3	.7	.1

[1] Made in cooperation with the office of Biophysical Investigations of the Bureau of Plant Industry.

TABLE I.—*Summary of climatological observations made at the Huntley Experiment Farm, 1911 to 1917, inclusive*—Continued.

MONTHLY TEMPERATURE (°F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Mean:													
1911	14.2	16.1	39.1	43.2	53.8	68.5	67.6	64.1	58.2	44.8	24.9	13.6	.....
1912	16.6	29.1	18.7	46.5	55.5	66.8	67.2	66.6	50.1	44.7	38.7	29.7	.....
1913	14.0	17.7	24.0	46.4	55.0	65.9	68.0	70.0	57.3	41.0	38.2	30.6	.....
1914	27.0	19.0	26.0	45.0	56.0	63.0	75.0	68.0	58.0	48.0	39.0	15.0	.....
1915	19.0	26.0	33.0	54.0	53.0	59.0	65.0	69.0	52.0	48.0	30.0	23.0	.....
1916	4.0	24.0	39.0	45.0	51.0	62.0	73.0	68.0	56.0	42.0	32.0	14.0	.....
1917	18.0	19.0	24.0	41.0	51.0	60.0	75.0	68.0	59.0	44.0	43.0	18.0	.....
Maximum:													
1911	50.0	40.0	74.0	77.0	92.0	94.0	97.0	97.5	94.0	84.5	55.0	55.0	.....
1912	53.0	52.0	62.0	78.0	90.0	99.5	95.0	93.0	89.0	79.0	69.0	59.0	.....
1913	56.0	63.0	61.0	82 0	89.0	98.0	98.0	97.0	94.0	81.0	67.0	55.0	.....
1914	58.0	54.0	68.0	75.0	83.0	93.0	100.0	99.0	89.0	80.0	69.0	48.0	.....
1915	52.0	54.0	66.0	86.0	82.0	87.0	94.0	97.0	89.0	80.0	71.0	42.0	.....
1916	52.0	60.0	74.0	87.0	90.0	91.0	100.0	97.0	94.0	78.0	68.0	58.0	.....
1917	52.0	61.0	56.0	74.0	90.0	89.0	103.0	96.0	93.0	83.0	71.0	47.0	.....
Minimum:													
1911	−26.0	−19.0	− 3.0	17.0	24.0	40.0	41.0	33.5	28.0	14.0	−20.5	−26.0	.....
1912	−35.0	− 5.0	−27.0	20.0	32.0	36.0	44.0	40.0	24.0	17.0	13.0	1.0	.....
1913	−32.0	−21.0	−25.0	20.0	31.0	42.0	43.0	44.0	29.0	20.0	14.0	− 5.0	.....
1914	− 6.0	−38.0	− 3.0	17.0	22.0	36.0	44.0	38.0	33.0	24.0	− 3.0	−23.0	.....
1915	−28.0	− 4.0	11.0	25.0	28.0	36.0	41.0	43.0	32.0	20.0	5.0	13.0	.....
1916	−39.0	−20.0	− 5.0	19.0	23.0	36.0	45.0	44.0	26.0	13.0	−13.0	−22.0	.....
1917	−37.0	−26.0	−20.0	12.0	28.0	34.0	43.0	40.0	32.0	− 4.0	15.0	−17.0	.....

KILLING FROSTS.

Year.	Last in spring.		First in autumn.		Frost-free period.
	Date.	Minimum temperature.	Date.	Minimum temperature.	
		°F.		°F.	*Days.*
1911	May 26	32	Sept. 18	28	114
1912	May 13	28	Sept. 16	31	125
1913	May 5	31	Sept. 19	29	136
1914	May 12	32	Oct. 6	31	146
1915	May 21	32	Sept. 19	32	120
1916	May 16	30	Sept. 13	31	119
1917	May 31	31	Sept. 28	32	119

CROP CONDITIONS.

Conditions during the early part of the season were rather unfavorable for getting crops started. Cool, wet weather prevailing during the spring months, planting was much delayed, and many fields on the project were not planted until after June 1. The rainfall during the remainder of the growing season was light, with the result that the crop yields on dry lands were low. On the irrigated lands the yields were also below the average. Weather conditions during the fall months were excellent for harvest and for fall plowing, and this work was completed in good season.

The acreage, yields, and farm values of crops produced on the project in 1917 are shown in Table II. These figures were furnished by the United States Reclamation Service.

The total cropped area in 1917 was 19,121 acres contained in 601 farms. This was an increase over 1916 of slightly more than 500

acres. Nearly one-third of the entire cropped area was in alfalfa, this crop occupying 6,002 acres, an increase over 1916, when the area in alfalfa was 5,422 acres. There was a marked decline in the acreage of sugar beets. In 1916 there were 5,264 acres planted to this crop, while in 1917 there were only 3,366 acres. To offset this decrease in sugar beets there was an increase in the acreage planted to wheat. In 1916, 2,624 acres of wheat were grown, while in 1917 there were 4,329 acres. This increased wheat acreage was brought about by the higher market value of wheat in 1917. The value per acre of this crop as reported was in 1916, $17.35, while in 1917 it was $36.22. The average farm value per acre of all crops was $36.16, while in 1916 it was $26.32.

TABLE II.—*Acreage, yields, and farm values of crops produced on the Huntley Reclamation Project in 1917.*

Crop.	Area (acres).	Unit of yield.	Yields.			Farm values.		
			Total.	Per acre.		Per unit of yield.	Total.	Per acre.
				Average.	Maximum.			
Alfalfa hay	6,002	Ton	14,062	2.34	5	$14.70	$206,838	$34.46
Alfalfa seed	13	Bushel	56	4.39	8.3	14.63	820	64.27
Apples	2	do	40	20	20	1.00	40	20.00
Barley	109	do	1,304	12	43.5	1.20	1,568	14.42
Beans	129	do	376	2.93	48	6.19	2,331	18.12
Beets, sugar	3,366	Ton	28,553	8.48	14.2	7.27	207,562	61.66
Cane	16	do	105	7	10	10.24	1,075	71.66
Clover hay	79	do	103	1.31	3	17.92	1,846	23.51
Clover seed	121	Bushel	509	4.22	10	9.62	4,890	40.58
Corn, Indian	186	do	3,497	18.78	70	1.46	5,101	27.39
Sorghum	6	Ton	18	3	4	10.00	180	30.00
Corn fodder	67	do	107	1.6	3	11.08	1,180	17.74
Flax	11	Bushel	5	.45	1	2.00	10	.91
Fruits, small	.62						88	140.00
Garden	200						12,721	63.70
Hay [1]	397	Ton	402	1.01	4	17.23	6,921	17.42
Millet seed	9	Bushel	66	7.76	13.3	1.23	81	9.55
Oats	2,420	do	70,470	29.11	90	.78	54,915	22.69
Pasture	1,451						9,237	6.36
Potatoes	164	Bushel	21,272	130	500	.77	16,301	99.65
Rye	6	do	71	12.9	14	1.60	114	20.73
Wheat	4,330	do	83,450	19.25	50	1.88	156,838	36.22
Sweet clover	22	Ton	14	.65	.65	7.00	98	4.55
Cucumbers	3						77	25.67
Wheat (dry)	976	Bushel	12,002	12.30	21.5	1.92	23,065	23.65
Total	19,104						690,760	
Average								36.16

[1] Hay other than alfalfa and clover.

LIVE STOCK.

A statement of the number and value of live stock on the project is presented in Table III. These figures were obtained from the United States Reclamation Service.

The number of dairy cattle increased from 1,753 on January 1 to 1,948 on December 31, 1917, and there appears to be a steady increase in the development of this industry. There was a slight decrease in the number of hogs, due to the high prices of feed and to the

fact that a large number of breeding stock were disposed of in 1916. The decrease in the number of sheep was probably a result of the lower beet acreage and the high price of alfalfa hay, since most of the sheep on the project are brought in from near-by ranges and are kept only for a short feeding period during the fall and winter, being used to pasture beet tops.

TABLE III.—*Live stock on the Huntley Reclamation Project in 1917.*

Item.	Inventory, Jan. 1.			Inventory, Dec. 31.			Increased or decreased total value.
	Number.	Average value.	Total value.	Number.	Average value.	Total value.	
Horses	1,961	$123.95	$243,095	2,145	$131.73	$282,570	$39,475
Mules	58	137.75	7,990	80	134.56	10,765	2,775
Cattle:							
Beef	1,982	41.55	82,337	1,795	45.71	82,060	−277
Dairy	1,753	63.80	111,881	1,949	54.02	105,290	−6,591
Sheep	3,729	5.80	21,578	1,974	8.13	16,064	−5,514
Hogs	2,791	8.00	22,328	2,363	15.40	36,365	14.037
Fowls	16,418	.54	8,900	16,920	6.10	10,343	1,443
Bees, hives	282	3.33	939	296	3.17	940	1
Total			499,048			544,397	45,349

CROP-ROTATION EXPERIMENTS.[1]

The chief purpose of the experimental work with crop rotations under irrigation is to determine quantitatively which of the crop sequences are the most favorable for the production of the various crops and also to ascertain the value of manuring. It is generally believed that a rotation of crops and the use of farm manure are beneficial, but there is very little definite knowledge as to just how beneficial they are, or, in other words, whether crop rotation or manuring is really worth while on these new irrigated lands.

The rotations and their cultural treatments in these experiments are listed as follows:

No. 1.—Oats (continuously cropped), fall plowed.

No. 2.—Beets (continuously cropped), fall plowed.

No. 3.—Spring wheat (continuously cropped,) fall plowed.

No. 4.—Potatoes (continuously cropped), fall plowed.

No. 5.—Spring wheat (continuously cropped,) fall plowed.

No. 6.—Corn (continuously cropped), fall plowed.

No. 7.—Spring wheat (continuously cropped), straw returned each year, fall plowed.

No. 8.—Alfalfa (continuously cropped).

No. 9.—Flax (continuously cropped), fall plowed.

No. 16.—Two years:
Oats on disked corn ground.
Corn, fall plowed.

No. 18.—Two years:
Spring wheat on disked beet ground.
Beets, fall plowed.

No. 20.—Two years:
Potatoes, fall plowed.
Beets, fall plowed.

No. 21.—Two years:
Potatoes, fall plowed.
Beets (manured), fall plowed.

[1] These experiments were under the immediate charge of Mr. Edward G. Noble, who prepared the report here made.

No. 22.—Two years:
Oats on disked beet ground.
Beets, fall plowed.

No. 23.—Two years:
Oats (manured) on disked beet ground.
Beets, fall plowed.

No. 24.—Two years:
Oats on disked potato ground.
Potatoes, fall plowed.

No. 25—Two years:
Oats (manured) on disked potato ground.
Potatoes, fall plowed.

No. 26.—Two years:
Corn, fall plowed.
Potatoes, fall plowed.

No. 27.—Two years:
Oats on disked potato ground (rye seeded in oat stubble in fall).
Potatoes, spring plowed.

No. 28.—Two years:
Spring wheat, fall plowed.
Oats, fall plowed.

No. 30.—Three years:
Potatoes, fall plowed.
Oats on disked potato ground.
Beets, fall plowed.

No. 31.—Three years:
Potatoes, fall plowed.
Oats (manured) on disked potato ground.
Beets, fall plowed.

No. 32.—Three years:
Corn, fall plowed.
Oats on disked corn ground.
Beets, fall plowed.

No. 40.—Four years:
Potatoes, crowned, fall plowed.
Beets, fall plowed.
Alfalfa on disked beet ground.
Alfalfa.

No. 42.—Four years:
Oats, crowned, fall plowed.
Beets, fall plowed.
Alfalfa on disked beet ground.

No. 44.—Four years:
Potatoes, crowned, fall plowed.
Oats on disked potato ground.
Alfalfa, seeded in oat stubble in fall.
Alfalfa.

No. 60.—Six years:
Potatoes, crowned, fall plowed.
Oats on disked potato ground.
Beets, fall plowed.
Alfalfa on disked beet ground.
Alfalfa.
Alfalfa.

No. 61.—Six years:
Potatoes, crowned, fall plowed.
Oats (manured) on disked potato ground.
Beets, fall plowed.
Alfalfa on disked beet ground.
Alfalfa.
Alfalfa.

No. 67.—Six years.
Corn, crowned, fall plowed (hogged off).
Flax on disked corn ground.
Beets, fall plowed.
Alfalfa on disked beet ground.
Alfalfa.
Alfalfa, pastured with hogs.

The above rotations were begun in field K in 1912. In 1916 a new series of rotations was started in field L–IV. These are listed as follows:

No. 1a.—Oats (continuously cropped), fall plowed.

No. 2a.—Beets (continuously cropped), fall plowed.

No. 4a.—Potatoes (continuously cropped) fall plowed.

No. 6a.—Corn (continuously cropped), fall plowed.

No. 8a.—Alfalfa (continuously cropped).

No. 34.—Three years:
Potatoes, fall plowed.
Beets, fall plowed.
Oats on disked beet ground.

No. 35.—Three years:
Potatoes, fall plowed.
Beets, fall plowed.
Oats (manured) on disked beet ground.

No. 46.—Four years:
Beets, crowned, fall plowed.
Oats on disked beet ground.
Alfalfa, seeded in oat stubble in fall.
Alfalfa.

No. 64.—Six years:
Potatoes, crowned, fall plowed.
Beets, fall plowed.

No. 64.—Six years—Continued.
Oats on disked beet ground.
Alfalfa, seeded in oat stubble in fall.
Alfalfa.
Alfalfa.

No. 69.—Six years:
Corn, crowned, fall plowed; hogged off; rape seeded in the fall between corn rows.

No. 69.—Six years—Continued.
Corn, fall plowed; hogged off; rape seeded in the fall between corn rows.
Oats on disked corn ground.
Alfalfa, seeded in oat stubble in fall.
Alfalfa.
Alfalfa, pastured with hogs.

CROP YIELDS.

With the season of 1917 the experiment completes its sixth year. It is still too early to draw any definite conclusions, however. The six-year rotations have just completed their first cycle, and soil variation still remains an important factor. It is, nevertheless, possible to see in the results obtained in 1917 and in each of the four previous years some indications which may be useful to those engaged in crop production under conditions similar to those where this experiment is conducted. A summary of the yields secured in these experiments since 1913 is given in Table IV.

TABLE IV.—*Average, maximum, and minimum yields of all crops in the irrigated rotations on the Huntley Reclamation Project in 1917 and the average yields of the same crops in 1913, 1914, 1915, and 1916.*

Crop.	Variety.	Number of plats.	Unit of yield.	Yield per acre.						
				1917			1916	1915	1914	1913
				Maximum.	Minimum.	Average.				
Alfalfa:										
Spring seeded	Montana	6	Ton	2.39	1.84	2.03	2.07	2.34	2.22	2.20
Fall seeded	do	3	do	3.73	3.17	3.42				
Second year	do	11	do	6.28	4.77	5.71	5.26	7.14	5.40	5.85
Third year	do	2	do	5.90	4.86	5.38	6.26	7.00	5.26	5.35
Continuously cropped.	do	4	do	5.35	3.99	4.65	4.98	4.72	4.62	4.51
Sugar beets	Kleinwanzlebener.	19	do	13.0	5.92	9.82	11.17	9.58	11.16	13.08
Potatoes	Mills Prize	17	Bushel	311.6	70.4	218.2	240.3	301.8	167.8	212.7
Oats	Swedish Select	21	do	116.9	34.6	75.0	78.2	79.3	89.8	84.2
Wheat	Pringle Champlain.	5	do	35.7	16.6	26.5	26.5	32.3	32.7	27.2
Corn	Northwestern Dent.	8	do	35.0	25.2	32.6	36.3	36.9	42.9	42.0
Flax	Minnesota No. 25	2	do	30.3	7.6	18.9	17.7	21.3	18.6	21.7

Table IV shows a wide difference between the highest and the lowest yields obtained from the different plats. In most cases the maximum yield was more than twice the minimum. Each crop was planted on the various plats at the same time, the same variety of seed was used on all plats, and the cultural treatment was the same, so that the differences in yield must be due to differences in the plats. These differences between the plats on which the same crop is planted may be due in part to soil variation and in part to the effect of the preceding crop, or in certain cases to manuring. It is impossible

to give an exact statement regarding soil variation. During the first years of a rotation experiment, soil variation is doubtless an important factor, but as time goes on it will be possible to analyze the results in such a way as to reduce this factor materially.

Table V shows the yields of oats, potatoes, and sugar beets for each rotation in 1917, with the immediately preceding crop in each case. The yields are arranged in their order from the highest to the lowest. An inspection of this table will readily show which of the preceding treatments gave the best results in 1917. It should be kept in mind, however, that all of the plats are probably not on equally good soil and that these results are for one season only.

TABLE V.—*Yields of oats, potatoes, and beets, with preceding crops, in the irrigated rotation experiments on the Huntley Experiment Farm in 1917.*

Oats.			Potatoes.			Beets.		
Preceding crop.	Rotation No.	Yield.	Preceding crop.	Rotation No.	Yield.	Preceding crop.	Rotation No.	Yield.
		Bush.			*Bush.*			*Tons.*
Beets	34	116.9	Alfalfa	64	311.6	Oats (manured)	61	13.00
Potatoes	61	110.6	do	61	296.7	do	23	12.46
Beets	46	106.8	Oats (manured)	25	292.4	Potatoes (manured).	21	12.07
Do	35	102.3	Beets (manured)	21	276.7			
Corn (hogged)	69	99.6	Oats	34	272.9	Beets	2a	11.94
Beets	64	95.6	Oats (manured)	35	265.9	Flax	67	11.91
Alfalfa	42	89.4	Beets	20	241.3	Oats	22	11.32
Potatoes	60	86.8	Corn	26	239.6	Potatoes	34	10.52
Do	25	84.8	Alfalfa	60	238.3	do	64	10.31
Beets	2	81.5	Oats	24	229.5	do	35	10.26
Oats	1a	76.8	Alfalfa	40	224.5	Oats (manured)	31	9.62
Beets	23	70.5	Potatoes	4a	213.2	Potatoes	20	9.58
Potatoes	24	68.5	Alfalfa	44	181.7	Alfalfa	46	9.57
Do	44	61.6	Beets	30	175.0	Wheat	18	9.11
Corn	16	55.8	do	31	90.7	Beets	2	8.47
Do	32	50.5	Potatoes	4	88.7	Potatoes	40	8.41
Potatoes	31	50.0	Oats (followed by rye)	27	70.4	Oats	60	8.27
Do	27	46.1				do	32	7.11
Do	30	45.9				do	30	6.66
Oats	1	40.8				do	42	5.92
Wheat	28	34.6						
Average of all plats		75.0			218.2			9.82

Summarizing the results obtained from these rotation experiments for the years 1912 to 1917, inclusive, the following comments may be made on each crop grown:

Alfalfa seeded in the fall in oat stubble produces more tons per acre of hay than when seeded the following spring. This part of the experiments, however, has been carried on only since 1916, and the results recorded are for a single year. The maximum production of alfalfa is usually reached during the second year.

Sugar beets grown in a rotation following a cultivated or a manured crop make the greatest yields. When grown after oats without manure the beets are usually small and the tonnage low.

The importance of growing potatoes in a rotation which includes alfalfa or a manured crop is indicated in the results secured each year.

The highest yields of oats are usually obtained in rotations including alfalfa or a manured crop. Oats following oats or wheat have proved to be an undesirable sequence, as a very low yield is usually secured.

A larger average yield of wheat has been secured in the 2-year rotation with sugar beets. Wheat grown on the same plat for six years yielded an average of 30.8 bushels per acre. On an adjoining plat, also seeded to wheat for six years, but having the straw returned each fall and plowed under, the average yield was 31.4 bushels per acre.

Three of the eight plats of corn grown in these rotations are harvested by hogs, and the results are reported under "Hogging corn." The highest yields of corn are secured in rotations in which the corn follows alfalfa or a cultivated crop.

The advantage of growing flax in a rotation as compared with continuous cropping has been clearly demonstrated from year to year. The yield of the former for the past six years has been more than double the latter.

PASTURING ALFALFA WITH HOGS.

The pasturing tests in connection with the rotation experiments are conducted on two quarter-acre plats, one in rotation 67, field K, and the other in rotation 69, field L–IV. The pasturing season is divided into two periods: April to July, the spring period, and July to October, the summer period. Fall pigs are used in the first and spring pigs in the second period. In each case pigs are put on at the rate of 2,000 to 2,500 pounds per acre.

TABLE VI.—*Results, calculated to an acre basis, of the alfalfa pasturing experiment on the Huntley Experiment Farm for the 5-year period, 1913 to 1917, inclusive.*

Year.	Rotation No.	Number of hogs.		Number of days.	Weight (pounds).		Gain (pounds).		
		Spring.	Summer.		Initial.	Final.	Total.	Daily average per hog.	Grain fed per pound.
1913 [1]	67	.....	48	41	2,788	3,624	836	0.50	2.65
1914	67	16	36	138	3,272	5,572	2,300	.42	2.78
1915	67	20	32	150	4,364	6,840	2,476	.70	3.13
1916	67	20	32	145	3,520	6,552	3,032	.85	2.79
1917	67	16	36	150	3,280	5,460	2,180	.74	2.87
1917	69	20	32	152	3,288	5,768	2,480	.72	2.64
Average	.....	18	34	147	3,545	6,038	2,493	.69	2.84

[1] As only the third crop of alfalfa was pastured in 1913 these results are not included in the average.

The plat is divided into two equal areas and the hogs pastured alternately on each area for a period of 9 to 12 days, depending upon weather conditions and the growth of the alfalfa. This arrangement allows for a more uniform growth of the alfalfa and convenience in irrigating. The hogs are weighed at the end of each 14-day period, and the results are reported on an acre basis. In addition to the pasture, shelled corn is fed at the rate of 2 pounds daily per 100 pounds

of live weight. The hogs were fed this supplementary ration in one meal, which was given in the evening.

The results obtained from pasturing alfalfa with hogs for the years 1913 to 1917, inclusive, are shown in Table VI.

HOGGING CORN.

The spring pigs used in the alfalfa pasturing experiment are used to hog off corn in the fall. These hogs are put on the plats of mature corn at the rate of 1,000 to 1,500 pounds per acre.

Table VII gives the results obtained from hogging corn for the six years, 1912 to 1917, inclusive, the results being reported on an acre basis.

TABLE VII.—*Results, calculated to an acre basis, of the experiment in hogging corn on the Huntley Experiment Farm for the 6-year period, 1912 to 1917, inclusive.*

Item.	1912	1913	1914	1915	1916	1917	Average.
Number of hogs	20	16	16	16	16	16	17
Period covered	Sept. 18 to Oct. 4.	Sept. 26 to Oct. 19.	Sept. 22 to Oct. 14.	Oct. 1 to Oct. 25.	Sept. 23 to Oct. 13.	Oct. 8 to Nov. 1.	
Time of test.....days..	16	23	22	25	20	24	22
Total initial weight, pounds	2,900	1,312	1,380	1,376	1,516	1,200	1,614
Total final weight, pounds	3,288	2,080	2,276	2,240	2,188	1,828	2,317
Total gain.....pounds..	388	768	896	864	672	628	703
Pork per acre per day, pounds	24.2	33.3	40.7	32.6	33.6	25.2	31.6
Estimated yield...bushels..	36.4	60.0	50.4	52.4	60.0	43.2	50.4
Estimated grain fed per pound of gain...pounds..	5.3	4.4	3.2	4.5	5.0	3.8	4.4

HOGGING CORN AND RAPE.

In rotation 69 Dwarf Essex rape at the rate of 4 pounds to the acre is seeded broadcast between the corn rows about the last of July. By the time the corn is mature in the fall and the rape has made fairly good growth, the hogs are taken off the alfalfa pasture and put on the corn plats in this rotation. The results obtained from hogging corn and rape for the years 1916 and 1917 are given in Table VIII.

TABLE VIII.—*Results, calculated to an acre basis, of the experiments in hogging off corn and rape on the Huntley Experiment Farm, 1916 and 1917.*

Item.	Year.		Average.
	1916	1917	
Number of hogs	8	16	12
Period covered	Sept. 23–31	Oct. 10–Nov. 1.	
Time of test.....days..	38	22	30
Total initial weight.....pounds..	660	1,168	914
Total final weight.....do....	1,246	1,700	1,473
Total gain	586	532	559
Pork per acre per day.....do....	15.42	24.18	19.8
Estimated yield.....bushels..	50.8	411	45.9
Estimated grain fed per pound of gain.....pounds..	4.85	4.33	4.6

Comparing the average results for five years of hogging corn without rape with the average of two years of hogging corn and rape, there seems to be no increase in gain in favor of the rape. This comparison is made in Table IX.

TABLE IX.—*Comparison of results, calculated to an acre basis, of the experiment in hogging corn, with and without rape, at the Huntley Experiment Farm.*

Item of comparison.	5-year average without rape.	2-year average with rape.
Number of hogs per acre	17	12
Time of test.....days	22	30
Total initial weight.....pounds	1,614	914
Total final weight.....do	2,317	1,473
Total gain per acre.....do	703	559
Pork per acre per day.....do	31.6	19.8
Estimated yield of corn.....bushels	50.4	45.9
Estimated grain fed per pound of gain.....pounds	4.4	4.6

IRRIGATED PASTURES.

Experiments with irrigated pastures were begun in 1911, and increasing attention has been given to this work each year since that time. From the results secured in preliminary tests of pasture mixtures and individual grasses, selection was made of the grasses that appeared to be best suited to the conditions. Tests were made of these in various mixtures, and experiments were conducted in methods of seeding. Carrying-capacity tests in a limited way were also conducted during the past four seasons.

ESTABLISHING PASTURES.

An experiment was conducted in 1916 on 24 quarter-acre plats in field L–III in which three pasture mixtures were seeded in duplicate by each of four methods. The methods employed were: *a*, Spring seeded, with a nurse crop of wheat cut for grain; *b*, spring seeded, with a nurse crop of wheat cut for hay; *c*, spring seeded, without a nurse crop; and *d*, late summer seeded, in wheat stubble. The three mixtures and the rate of seeding per acre for each are given in Table X.

TABLE X.—*Pasture mixtures and rates of seeding in a method-of-seeding test at the Huntley Experiment Farm in 1917.*

Pasture mixture.	Rate per acre of seeding (pounds).		
	Mixture No. 1.	Mixture No. 2.	Mixture No. 3.
Awnless brome-grass	2	2	.....
Orchard grass	5	5	5
Tall rescue	3	3	3
Perennial rye-grass	3	3	.....
Kentucky bluegrass	4	4	4
White clover	2	.....	2
Alsike clover	2	.....	2
Total	21	17	16

In this test a good stand of all the grasses was secured by each method of planting, although there was a rather marked difference in the growth on the different plats in 1917. All of the plats were irrigated uniformly three times during the season. In 1917 two crops of hay were harvested from each plat. The yields of hay secured, which are in each case the average of two plats, are shown in Table XI.

TABLE XI.—*Yields of grass hay in the method-of-seeding test in field L–III on the Huntley Experiment Farm in 1917.*

Mixture.	Method of seeding.	Yield per acre (tons).			
		First crop.	Second crop.	Total.	Average of 8 plats.
No. 1	a	1.31	1.44	2.75	2.76
	b	1.05	1.63	2.68	
	c	2.53	1.69	4.22	
	d	.39	.99	1.38	
No. 2	a	1.10	.93	2.03	2.01
	b	.82	.95	1.77	
	c	2.17	1.26	3.43	
	d	.21	.61	.82	
No. 3	a	1.11	1.01	2.12	2.20
	b	.89	.89	1.78	
	c	2.11	1.40	3.51	
	d	.33	1.05	1.38	

Average yield per acre of 6 plats: Seeded by method *a*, 2.31 tons; method *b*, 2.08 tons; method *c*, 3.72 tons; method *d*, 1.19 tons.

Table XI shows that there was a wide difference in yield of the first crop and that the higher yields in each case were secured from the plats seeded without a nurse crop. There was no significant difference in yield from the nurse-crop plats between the plats harvested for hay and those harvested for grain. The yields of the first crop on the plats seeded in late summer were in all cases relatively low. The differences in yield in the second crop were not so marked, although in most cases the yields from the plats seeded without a nurse crop were still somewhat higher. Considering the total yields, the late summer seeded plats were always lower than the yields from the nurse-crop plats. The average yield of all the eight plats seeded to mixture No. 1, regardless of the seeding method, was higher than the average yield of the plats seeded to either of the other mixtures. The lowest yield was from mixture No. 2, which does not contain clover. From the results obtained in this experiment in the two years it would appear that the nurse-crop method of seeding is the most profitable, since a crop of grain is secured the first year. The successful establishment of pastures by this method, however, requires that very close attention be given during the first season and that irrigation be applied to meet the needs of the grass rather than those of the nurse crop and that the nurse crop be removed very

soon after the harvest in order to allow irrigation of the grasses. In late summer seeding it is usually possible to obtain a good stand of pasture grasses, but because of the short period after seeding and before winter the grasses do not become well established and are slow in beginning growth the following spring. Consequently, not as much pasture is produced during the second season as on pasture seeded in the spring. The method of spring seeding without a nurse crop is considered to be the safest and most certain to give a good stand and will produce much more pasture during the second season than either of the other methods, as well as furnish some pasture during the latter part of the first season.

CARRYING CAPACITY WITH COWS.

A pasture carrying-capacity test was conducted in 1917 on four quarter-acre plats of mixed grasses in field A–II. In this test two cows were pastured during the entire season and a third cow was pastured during a part of the season. Three of these plats were used for pasture in 1914, 1915, and 1916. The fourth plat was planted in 1916 to a mixture of awnless brome-grass, orchard grass, tall fescue, Kentucky bluegrass, white clover, and alsike clover. Two of the plats used for pasture in previous seasons were planted in 1913, one to a mixture of awnless brome-grass, orchard grass, meadow fescue, tall fescue, Italian rye-grass, Kentucky bluegrass, and tall oat-grass, and the other to the same mixture with the addition of white clover and alsike clover. The remaining plat was planted in 1911 to a mixture of awnless brome-grass, orchard grass, redtop, and timothy. The plats were fenced in two inclosures of two plats each, and each plat was pastured alternately for periods of from 7 to 14 days. Each part of the pasture was irrigated seven times during the season. One-half of each plat was top-dressed with manure at the rate of 10 loads per acre. The effect of this manuring was very noticeable in the increased growth of the grasses on this part of the pasture. The pasture period began on May 14 and ended October 5, during which time two cows were on the pasture continuously with the exception of a total of 11 days at different times during the season, when they were kept off during stormy weather to prevent injury to the pasture by trampling. The third cow was on pasture for a total of 57 days at different times during the first four months of the pasture period. The total number of cow days was 325. During the season the cows produced from the acre of pasture a total of 5,777 pounds of milk, which contained 259 pounds of butter fat. At local market prices for butter fat, which ranged from 41 cents per pound in May to 50 cents in September, this had a value of $107.90. During the 11 days that the cows were kept off pasture and from September 25 to the end of the season, alfalfa hay at the rate of 30 pounds per head per day was

fed. The value of this hay at $15 per ton was $9.90, so that the value of the butter fat produced from the 1 acre of pasture, after deducting the value of the hay fed, was $96. One of these cows freshened in September, 1916; one in October, 1916; and the third in January, 1917. All of the cows were grade Jerseys.

PASTURING SHEEP.

A sheep-pasturing test was conducted on four quarter-acre plats of mixed grasses in field B–V. These plats were seeded in 1915 to a mixture of awnless brome-grass, orchard grass, meadow fescue, Kentucky bluegrass, perennial rye-grass, tall fescue, and white clover. Two of the plats were used for sheep pasture in 1916 and the remaining two plats for cow pasture in 1916.

The test was started on May 23. Eight high-grade Hampshire ewes and their lambs were used in the test. The ewes averaged 125 pounds in weight and the lambs 55 pounds when placed on the pasture. The sheep were divided into two lots of four ewes and four lambs each, and for each lot a half acre of pasture was used. Each half of the pasture was fenced separately and pastured alternately for periods of from 5 to 10 days. It was found that the amount of pasture produced was not sufficient to carry this number of sheep continuously, and it became necessary to remove the sheep from the pasture for two different periods in June and July. The sheep were off pasture from June 15 to 22 and from July 2 to 31. The pasture period ended on September 29. The sheep were on pasture a total of 100 days during the season. During the time that they were on pasture the ewes gained a total of 131 pounds and the lambs 176 pounds, making a total gain of 307 pounds for the ewes and lambs on the 1 acre of pasture. From the results secured in this test and in a similar test in 1916 it seems probable that the carrying capacity of pastures will be about six ewes and their lambs per acre.

CLOVER SEED-PRODUCTION TEST.

A test of seed production was conducted in 1917 with three species of clover (red, alsike, and white) on eight plats of each species in field L–I and L–II. These clovers were seeded in 1916 in a method-of-seeding test in which four methods were used with each species. The methods of seeding were as follows: *a*, Spring seeded, with a nurse crop of wheat cut for hay; *b*, spring seeded, with wheat as a nurse crop cut for grain; *c*, spring seeded, without a nurse crop; and *d*, late summer seeded, in wheat stubble.

In the seed-production test in 1917 three methods with each species were employed as follows: (1) The clover clipped early and the second growth left to produce seed; (2) the first crop harvested for hay at the usual time and the second crop left to produce seed; and (3) the first

crop left to produce seed. The plan of the test provided for handling the plats seeded by method *a* according to method No. 1 of seed production, the plats seeded by methods *b* and *c* according to seed-production method No. 2, and the plats seeded by method *d* according to seed-production method No. 3. It was not possible, however, to follow the plan exactly as outlined, since the stands of white and alsike clover on the plats seeded with a nurse crop and late summer seeded and of late summer-seeded red clover were rather light and slow in starting growth in spring. This resulted in a heavy weed growth, which made it necessary to keep the plats clipped in order to prevent the weeds from going to seed, and no clover seed was produced on these plats.

The yields obtained in the other plats and other data relating to this test are given in Table XII.

TABLE XII.—*Yields of hay and seed obtained in the seed-production test with red clover, alsike clover, and white clover on the Huntley Experiment Farm in 1917.*

Field and plat.	Variety of clover.	Seeding method.	Seed-production method.	Yield per acre.	
				Hay.	Seed.
				Tons.	*Bushels.*
L–I–3	Alsike	c	3		4.93
L–II–3	do	c	3		7.86
L–I–7	White	c	3		2.80
L–I–9	Common red	a	1	1.20	3.10
L–I–10	do	b	2	1.81	2.20
L–I–11	do	c	3		2.60
L–II–9	do	a	1	1.28	4.46
L–II–10	do	b	2	1.79	3.06
L–II–11	do	c	3		2.26

For thrashing it was necessary to use an ordinary thrashing machine, since a clover huller was not available. It was not possible to adjust this machine accurately for thrashing clover, and some of the seed was lost in this way.

The results of the test indicate that for the successful seed production of white and alsike clover the first season after planting, it is necessary to seed without a nurse crop and that the best results will be obtained by leaving the first crop to make seed. Red clover started fairly well with a nurse crop and made a good growth during the following season. While a good stand of red clover was secured by late summer seeding in wheat stubble, the crop was slow in starting growth in the following spring and could not keep ahead of the weeds. In this test the best results with red clover were obtained by clipping the first crop early and allowing the next crop to make seed. The yields of seed secured by harvesting the first crop at the usual time were about equal to the yields secured by leaving the first crop for seed. With white and alsike clover it seems desirable to leave the first crop for seed.

TEST FOR CONTROL OF THE SUGAR-BEET ROOT LOUSE.

In cooperation with the biology department of the Montana Agricultural Experiment Station, an experiment was started in 1914 in which varying quantities of irrigation water were applied to sugar beets in order to determine whether a greater amount of water than is ordinarily used in irrigating beets would result in controlling the damage done by invasions of the sugar-beet root louse. This experiment has been continued each year since that time with slight modifications.

Invasions of the root louse usually occur during the latter part of June or early July, when the lice migrate to beet fields from cottonwood trees on the river bottoms, where they are hatched. If the conditions are favorable at this time, the root louse enters the soil around the beets. They soon increase rapidly in numbers and unless they are checked will seriously damage the beet crop. A dry, cracked soil at the time the root lice are migrating appears to be an especially favorable condition for the lice to become established. In the experiment in 1917 two, three, four, and five irrigations were applied, while in previous years only two, three, and five irrigations were applied. In the case of the plants that were irrigated four and five times, the first irrigation was applied about two weeks earlier in the season than is usually considered necessary in ordinary practice, or just before the time of migration of the root lice, and the soil was kept thoroughly moist throughout the season. Where only two irrigations were given, the soil was allowed to become rather dry and cracked before each irrigation. In ordinary practice, beets are irrigated usually about three times during the season, and in this experiment the beets that received the three irrigations were irrigated as nearly as possible according to this practice.

The experiment was conducted in duplicate on eight tenth-acre plats in field C–IV and was replicated four times on 16 tenth-acre plats in field L–II. The dates of irrigation were as follows: Two irrigations, August 1 and 30; three irrigations, July 26 and August 8 and 22; four irrigations, July 12 and August 8, 14, and 28; five irrigations, July 12 and 26 and August 1, 14, and 28.

The extent of the infestation on any of the plats was unusually small at the time of harvest, although the season was very dry, which condition is generally considered favorable for the development of the root lice. The amount of infestation was determined by examining each beet at harvest time.

The yields obtained and other data relating to the test are given in Table XIII.

Table XIII shows that in field C–IV the amount of infestation was less on the plats receiving the larger number of irrigations, although the yields did not vary consistently and the lowest yield

was obtained from the plat that was irrigated five times. In field L–II there was a consistent increase in yield and decrease in the amount of infestation as the number of irrigations was increased. The results in field L are similar to those secured in previous seasons in this experiment. In all cases the sugar content was less in infested beets than in those not infested.

TABLE XIII.—*Results of an experiment in sugar-beet root-louse control on the Huntley Experiment Farm in 1917.*

Field.	Number of irrigations.	Yield per acre.	Sugar content of beets (per cent).			Beets injuriously infested.
			Not infested.	Infested.	Average field sample.	
		Tons.				*Per cent.*
C–IV[1]	2	7.30	20.4	19.0	20.2	4.6
	3	8.18	20.0	19.4	20.8	3.7
	4	7.00	20.5	20.3	22.0	1.4
	5	6.30	20.9	18.1	20.5	1.9
L–II[2]	2	9.50	16.0	16.3	15.9	3.0
	3	10.19	18.1	16.6	16.0	3.2
	4	11.04	16.9	15.8	15.0	1.7
	5	11.22	17.2	16.9	14.6	.8

[1] Average of two plats. [2] Average of four plats.

SILAGE CROPS.

CORN VARIETIES FOR SILAGE.

A variety test of corn for silage, in which three varieties, Minnesota No. 13, Northwestern Dent, and a local Yellow Dent, were grown in quadruplicate, was conducted on 12 quarter-acre plats in field A–IV. These varieties are all early maturing and were all sufficiently matured to make good silage at the date of harvest, which was September 24. The Northwestern Dent was somewhat better matured on this date than either of the other varieties. The average yields were as follows: Northwestern Dent, 10.53 tons per acre; local Yellow Dent, 8.47 tons per acre; and Minnesota No. 13, 6.82 tons per acre. The Northwestern Dent variety gave the highest yield in this test, and since it matures earlier than the others it appears to be one of the best varieties which have been tested to grow for silage on the Huntley project. The Northwestern Dent was also grown for silage in field B–VI, which contains 1.45 acres. The yield was at the rate of 9.03 tons per acre.

SUNFLOWERS FOR SILAGE.

A preliminary test of sunflowers for silage was conducted in field C–III. Seed of the Mammoth Black Russian variety was drilled with a corn planter in rows 40 inches apart. On one half of the field the plants were thinned to 6 inches apart in the row, and on

the other half to 15 inches. Each part of the field contains 0.36 acre. Each part of the field was irrigated five times during the season. The crop was harvested for silage on September 22, at which time on about 50 per cent of the plants the seeds were well formed and in the "dough" stage, while the remainder were not so nearly matured. The yield from the plat in which the plants were thinned to 15 inches apart was at the rate of 16.91 tons per acre, and from the plat thinned to 6 inches the yield was at the rate of 19.42 tons per acre. None of this silage has been fed as yet at the experiment farm, but from feeding tests made at the Montana Agricultural Experiment Station in recent years the indications are that sunflowers make good silage. Since the yield of this crop is much higher than can be secured from corn on the Huntley project, it seems probable that sunflowers for silage may become an important crop.

FRUIT TREES.

A variety test of apples, plums, and cherries was started in the orchard in field A in 1911. In the original planting about 100 varieties of these fruits were planted. Large numbers of these trees were lost by winterkilling each winter since the test was started. Varieties of which all the trees were lost were replaced by others that appeared to be more hardy. In 1916 there were 55 varieties remaining of those planted originally. An unusually large number of these trees were lost by winterkilling during the winter of 1916–17. Of a total of 147 apple trees alive in the fall of 1916, only 66 remained alive in the spring of 1917. The varieties that suffered least winter injury were Patten (*Patten's Greening*), Wealthy, and Hibernal. In the fall of 1916 there was a total of 29 crab-apple trees alive; only 4 of these trees were lost during the winter. Of a total of 20 sour cherry trees all except 2 were lost by winterkilling. About one-third of the plum trees, or 22 out of a total of 63, were winterkilled. A few of the crab-apple and plum trees produced small amounts of fruit, although most of the fruit was destroyed by late spring frosts.

FERTILIZER TEST.

A test of acid phosphate as a fertilizer has been conducted every year since 1913 on 12 twentieth-acre plats in field B–VII. Wheat, oats, and barley were grown in this test in 1913, oats in 1914 and 1915, and alfalfa in 1916 and 1917. Fertilizer was applied each year except 1917 at rates of 300, 500, and 700 pounds per acre and was worked into the soil at the time of preparing the seed bed. Each plat received the same treatment throughout the experiment. In 1917 no fertilizer was applied to the alfalfa, which was seeded in 1916. Check plats, to which no fertilizer was applied, were used each year. A summary of the results obtained in this test during the five years is

given in Table XIV. In 1913 the results given are the yields from one plat of each crop at each rate of applying fertilizer, while from 1914 to 1917, inclusive, the results in each case are the average of three plats.

TABLE XIV.—*Summary of results in the test of acid phosphate as a fertilizer for wheat, oats, barley, and alfalfa on the Huntley Experiment Farm during the 5-year period, 1913 to 1917, inclusive.*

Crop.	Year.	Yield per acre, fertilizer being used at the rate of—			
		No fertilizer.	300 pounds per acre.	500 pounds per acre.	700 pounds per acre.
Wheat.....bushels..	1913	42.0	46.0	48.3	48.6
Oats.....do....	1913	106.2	71.8	118.7	107.5
Barley.....do....	1913	53.3	67.0	50.4	67.0
Oats.....do....	1914	85.8	84.9	83.9	84.3
Do.....do....	1915	76.2	71.8	74.3	72.2
Alfalfa.....tons..	1916	1.45	1.64	1.45	1.62
Do.....do....	1917	5.32	5.65	5.41	5.48

The results show that the yields in no year varied greatly and that there were no significant differences in yields that might be attributed to the effect of the fertilizer.

EXPERIMENTS WITH HOGS.

In cooperation with the Animal Husbandry Division of the Bureau of Animal Industry[1] some experiments with hogs were started in 1917. These experiments included tests of different grain rations as a supplement to alfalfa pasture for hogs, a comparison of the relative value of corn and barley as a supplement to alfalfa pasture for pigs and for sows and litters, a comparison of single and divided alfalfa pasture, and a comparison of corn and barley for finishing hogs fed in a dry lot.

The alfalfa pasture in field A–II, which was used in this experiment, was seeded in 1912. Hay was harvested from these plats in 1913 and 1914, and an experiment in alfalfa-seed production was conducted in 1915 and 1916. The pasture for each lot of hogs was one-quarter acre in size, except for the lot on pasture without a supplement of grain, which was one-half acre in size.

FALL PIGS ON ALFALFA PASTURE.

Six lots of fall pigs were started on pasture on May 16. Lot 1 received no grain, lot 2 was fed a 1 per cent ration[2] of corn, lots 3 and 4 were fed a 2 per cent ration of corn, lot 5 was fed a 3 per cent ration of corn, and lot 6 was given all the corn that the pigs would

[1] These experiments were under the immediate supervision of Mr. C. V. Singleton, who was detailed by the Bureau of Animal Industry for this work.

[2] One pound of grain daily for each hundred pounds of live weight of pigs.

consume from a self-feeder. All the lots were on divided pasture except lot 4, for which the pasture was not divided. All except lots 1 and 2 were removed from the pasture on July 11 and placed in a dry lot for finishing. Lots 1 and 2 remained on pasture until September 19.

The pigs used in the test were grades of several different breeds and were rather ununiform in size. They were divided into lots as nearly uniform as was possible at the beginning of the test.

The results of the test are given in Table XV.

TABLE XV.—*Results of feeding fall pigs varying grain rations as a supplement to alfalfa pasture on the Huntley Experiment Farm in 1917.*

Item.	Lot 1.	Lot 2.	Lot 3.	Lot 4.	Lot 5.	Lot 6.
Area of pasture.....acres..	0.5	0.25	0.25	0.25	0.25	0.25
Number of pigs in lot.....	6	6	6	6	6	6
Pasture period.....days..	126	126	56	56	56	56
Average initial weight.....pounds..	77	76	81	78	78	79
Average final weight.....do....	93	119	124	124	134	174
Average daily gain.....do....	.13	.34	.77	.82	1.01	1.71
Gain per acre.....do....	190	872	860	920	1,356	2,292
Grain fed per pound of gain.....do....	.....	3.12	2.67	2.50	3.12	3.66

In Table XV, lot 1, alfalfa pasture with no grain, and lot 2, alfalfa pasture and 1 per cent of grain, are reported for the entire season of 126 days. During the first 56 days lot 1 made an average daily gain of 0.48 pound, while during the next 70 days these pigs lost in weight, and the average daily gain for the entire period of 126 days was only 0.13 pound. Lot 2 made an average daily gain of 0.62 pound during the first 56 days, but the gains made by this lot were much lower during the next 70 days, thereby reducing the daily gain per acre during the entire season to 0.34 pound. The amount of pasture in both these lots was ample during the entire season.

Lot 4, which was on single pasture, made slightly better gains than lot 3 on divided pasture. Neither of these pastures was closely grazed at any time, and the number of hogs in each was not sufficient to make a test of the full carrying capacity of the pasture. The difference in gains was probably due to the variation of individual pigs in these lots. The most economical gains as regards the amount of grain required per pound of gain were made by the lots on a 2 per cent grain ration.

SPRING PIGS ON ALFALFA PASTURE WITH VARYING GRAIN RATIONS.

The experiments that were conducted with fall pigs were repeated with spring pigs during the second period of the pasture season. A lot of spring pigs was added, to which a 2 per cent ration of barley was fed as a supplement to alfalfa pasture, so that there were in

all seven lots of spring pigs. The spring pigs in this test were on pasture from July 12 to October 3, a period of 84 days. The results secured in this experiment are shown in Table XVI.

TABLE XVI.—*Results of feeding spring pigs varying grain rations as a supplement to alfalfa pasture on the Huntley Experiment Farm in 1917.*[1]

Item.	Lot 1.	Lot 2.	Lot 3.	Lot 4.	Lot 5.	Lot 6.	Lot 7.
Area of pasture.....acres..	0.50	0.25	0.25	0.25	0.25	0.25	0.25
Number of pigs in lot.....	7	7	8	8	8	9	8
Average initial weight.....pounds..	35	34	35	34	35	35	35
Average final weight.....do....	46	49	65	63	63	81	111
Average daily gain.....do....	.14	.18	.36	.34	.33	.56	.90
Gain per acre.....do....	162	432	965	924	888	1,684	2,420
Grain fed per pound of gain.....do....	.....	2.33	2.88	2.92	2.95	3.09	3.09

[1] All pigs except those of lot 4 were on divided pasture; lot 4 was on single pasture. The supplementary grain rations were as follows: Lot 1, no grain; lot 2, 1 per cent corn; lots 3 and 4, 2 per cent corn; lot 5, 2 per cent barley; lot 6, 3 per cent corn; lot 7, full feed of corn.

The pigs that received no grain made very low gains and were in a very unthrifty condition at the close of the pasture season. Two of these pigs died during the latter part of the experiment, apparently because of the fact that they were not able to withstand severe weather conditions. Table XVI shows that the most economical gains as to amount of grain fed per pound of gain were made by the pigs on a 1 per cent grain ration, although these pigs were not in a thrifty condition. A comparison of lots 3 and 5 shows that lot 3 made slightly better and cheaper gains than lot 5. Lot 3, which was on divided pasture, made more gains and required less grain to make a pound of gain. The growth of the alfalfa on the divided pasture was somewhat better than on the single pasture. The amount of grain per pound of gain was the same in lot 6, in which a 3 per cent ration of grain was fed, as in lot 7, in which the pigs received a full ration of corn kept in a self-feeder.

SOWS AND LITTERS ON ALFALFA PASTURE.

A comparative test of corn and barley as a supplement to alfalfa pasture was made with three lots, each containing two sows and their litters. Lot 1 was given a 2 per cent ration of ground barley, and lots 2 and 3 were given a 2 per cent ration of corn. The pasture period extended from May 15 to July 11, a total of 56 days. The pasture for each lot was divided and was in each case one-fourth acre in size. The results of this experiment are shown in Table XVII.

The results indicate that the pigs that were fed on ground barley made slightly higher gains and consumed less grain per pound of gain than either of the lots receiving a 2 per cent ration of corn. The sows on barley were also maintained in better condition, and the loss in weight was less than when fed on corn.

TABLE XVII.—*Results of feeding sows and their litters a 2 per cent ration of corn and of barley as a supplement to alfalfa pasture on the Huntley Experiment Farm in 1917.*

Item.	Lot 1.	Lot 2.	Lot 3.
Number of sows	2	2	2
Number of pigs	13	12	10
Average initial weight of sows.....pounds..	250	267	263
Average initial weight of pigs.....do....	11	13	7
Average final weight of sows.....do....	230	235	229
Average final weight of pigs.....do....	33	35	32
Average daily gain of pigs.....do....	.39	.38	.44
Gain per acre (gain of pigs less loss of sows).....do....	988	780	702
Grain fed per pound of gain:			
Sows and pigs.....do....	2.53	3.32	3.81
Pigs.....do....	2.18	2.50	2.75

FINISHING FALL PIGS IN A DRY LOT.

Lots 1 and 2 of the fall pigs were continued on alfalfa pasture during the entire season. They were removed on September 19, placed in dry lot for finishing, and given a full ration of ground barley and all the alfalfa hay they would eat. On the same date lots 3 and 4, which had been on alfalfa pasture supplemented by a ration of 2 per cent corn, were placed in a dry lot and given a full ration of corn supplemented by hay. The results obtained with the four lots of hogs are presented in Table XVIII.

TABLE XVIII.—*Results of finishing fall pigs in a dry lot after spring pasture on the Huntley Experiment Farm in 1917.*

Item.	Ground barley.		Corn.	
	Lot 1.	Lot 2.	Lot 3.	Lot 4.
Number of hogs	6	5	5	6
Period in dry lot.....days..	37	28	42	42
Average initial weight.....pounds..	92	119	123	134
Average final weight.....do....	190	191	180	180
Average daily gain.....do....	2.64	2.50	1.33	1.08
Grain fed per pound of gain.....do....	3.41	3.62	4.70	4.89
Alfalfa hay fed.....do....	97	102	159	189

While Table XVIII shows that the hogs fed ground barley made more rapid and more economical gains than those fed on corn the results are not strictly comparable because of the difference in the size of the hogs when placed in the dry lot and the treatment given them previously. The hogs fed on barley were also handled under much more favorable conditions than the hogs fed on corn. The two lots of hogs on barley made an average daily gain of 2.6 pounds and required 3.5 pounds of grain per pound of gain. The hogs fed on corn made an average daily gain of 1.2 pounds and required 4.79 pounds of grain per pound of gain.

DRY-LOT FINISHING OF FALL PIGS ON VARYING GRAIN RATIONS.

It was originally intended at the close of the spring pasture period to place lots 3, 4, and 5 in dry lots on a full feed of corn and alfalfa hay and later when lots 1 and 2 were removed to finish them on the same rations. As there was such great variation in the size of the hogs at the end of the period, some in lot 5 weighing over 200 pounds, and as the conditions for dry-lot feeding were very poor, lot 5 was marketed at that time. Lots 3 and 4 were carried only to about 180 pounds instead of 200 pounds for the same reasons. The very poor returns from dry-lot feeding of these two lots may be attributed to two causes: (1) Only first-cutting hay was available for the first two periods; and little was consumed, and (2) the pigs were fed in small areas, which became very muddy. During the last period, when second-cutting hay was fed and the dry lots were in fair condition, the results obtained were very much better.

When lots 1 and 2 were removed from pasture no corn could be obtained, so they were finished on ground barley. The results from finishing these lots can hardly be compared with those from lots 3 and 4, as the conditions were much more favorable. The dry lots were in good condition at all times, and good third-cutting hay was fed. The detailed results of this experiment are shown in Table XIX.

TABLE XIX.—*Results of finishing pigs in a dry lot after the spring pasture season on the Huntley Experiment Farm in 1917.*

Item.	Lot 1.	Lot 2.	Lot 3.	Lot 4.	Lot 5.
Number of pigs	6	5	5	6	6
Period on pasture, days	126	126	56	56	56
Period in dry lot, do	37	28	42	42	0
Initial lot weight, pounds	555	598	619	807	1,045
Initial weight of pig, do	92.5	119.6	123.8	134.5	174.2
Final weight of lot, do	1,141	957	899	1,078	
Final weight per pig, do	190.2	191.4	179.8	179.7	
Gain of lot, do	586	359	280	271	
Gain per pig, do	97.7	71.8	56	45.2	
Gain per pig per day, do	2.64	2.56	1.33	1.08	
Grain consumed in feed lot, do	[a] 2,000.5	[a] 1,300	1,317	1,324	
Hay consumed, tons	97	102	[b] 159	[b] 189	
Grain fed per pound of gain, pounds	3.41	3.62	4.70	4.89	
Profit per lot (grain at $3.25, hay at $12, and hogs at $15)	$22.30	$10.99	−$1.75	−$3.51	
Profit per hog	3.72	2.20	− .35	− .58	

[a] Ground barley. [b] Practically all of this was consumed in the last 14 days.

It will be noted that lots 1 and 2 returned a fair profit from dry-lot feeding, while lots 3 and 4 gave a slight loss. The pigs in lots 1 and 2 were thin, with large frames, when the feeding was started and therefore could be expected to give better returns for feed consumed than those in lots 3 and 4; but a large share of this difference must be attributed to the difference in condition, as mentioned above. Lot 1 made daily gains of 2.64 pounds for 37 days and made 1 pound

of gain for every 3.41 pounds of grain consumed. This shows that although the pigs had been losing weight on alfalfa alone, they had not been stunted but were in good thrifty condition.

COMBINED PASTURE AND DRY-LOT PERIOD.

The practical economy of comparative grain rations can not well be determined without including the cost of finishing to market weight, as the grain ration while on pasture may have some effect on the returns from dry-lot feeding. (Table XX.)

TABLE XX.—*Results for the spring pigs from the time they went on pasture until ready for market on the Huntley Experiment Farm in 1917.*

Item.	Lot 1.	Lot 2.	Lot 3.	Lot 4.	Lot 5.
Area of pasture lot.....acres..	0.50	0.25	0.25	0.25	0.25
Number of pigs in lot.....	6	5	5	6	6
Period on pasture.....days..	126	126	56	56	56
Period in feed lot.....do....	37	28	42	42	.....
Total time.....do....	163	154	98	98	56
Initial weight of lot on May 16...pounds..	460	380	404	468	472
Initial weight per pig.....do....	76.7	76	80.8	78	78.7
Final weight of lot.....do....	1,141	957	899	1,078	1,045
Final weight per pig.....do....	190.2	191.4	179.8	179.7	174.2
Total gain of lot.....do....	681	577	495	610	573
Total grain consumed.....do....	2,000.5	1,981	1,892	2,384	2,097
Total hay or hay equivalent.....tons..	2.53	1.73	.64	.56	.35
Grain fed per pound of gain.....pounds..	2.94	3.43	3.82	3.91	3.66
Profit per lot (grain at $3.25, hay at $12, and hogs at $15).....	$6.77	$1.41	$6.08	$7.30	$13.60
Profit per pig.....	1.13	.28	1.02	1.22	2.27
Returns per ton of hay.....	14.68	12.82	19.94	25.04	50.86

A comparison of all lots shows a profit ranging from 28 cents per pig in lot 2 to $2.27 in lot 5. Lot 5 was also marketed in 56 days, compared to 98, 154, and 163 days for the other lots. These results would indicate that if pigs weigh 75 pounds or more it may be profitable to put them on a full grain ration at the beginning of the pasture season; as, in addition to returning a greater profit, they need not be kept on hand so long and therefore the danger of disease is less. Lots 1 and 2 returned very little profit despite their good record in the dry lot. This was no doubt due to the fact that they were held on pasture with no grain and on a 1 per cent grain ration at a loss for some time before they were moved to the dry lots.

DRY-LOT FINISHING OF SPRING PIGS FORMERLY ON VARYING GRAIN RATIONS.

When the summer pasture period was closed on October 3, the herds designated as lots 1, 2, 3, 4, 5, and 6 were placed in dry lots and put on a full feed of grain and alfalfa hay. It was intended to use corn for all pigs except those in lot 6, which were to be continued on ground barley, but as corn could not be purchased at that time all were put on a ration of ground barley. At several times during the

period it was necessary to change suddenly from barley to corn and vice versa, as it was very hard to obtain any kind of feed. Corn was fed from October 24 to 31, November 18 to December 1, and January 9 to 19. At one time, because of scarcity of feed and with poor prospects for purchasing any soon, all the lots were limited in the amount of grain given for a few days until more feed was purchased. The hogs were fed in very small lots which were without feeding floors, so that from the last of November to January 9 the lots became very muddy, and it was exceedingly difficult to keep the self-feeders working. This muddy condition of the lots, together with so many sudden changes in feed and the fact that the pigs were carried for a few days on a limited grain ration, no doubt accounts for the small daily gains and the rather large amount of grain required to make 1 pound of gain. The results of this experiment are shown in Table XXI.

TABLE XXI.—*Results of finishing pigs in a dry lot after the summer pasture period on the Huntley Experiment Farm in 1917.*

Item.	Lot 1.	Lot 2.	Lot 3.	Lot 4.	Lot 5.	Lot 6.
Number of pigs	7	7	8	9	[a] 7	8
Period on pasture.....days..	84	84	84	84	84	84
Period in dry lot.....do....	108	94	91	77	56	91
Weight when put in dry lot, pounds	324	345	521	732	784	500
Weight per pig.....pounds..	46.3	49.4	65.1	81.3	112	62.5
Final weight of lot.....do....	1,342	1,355	1,587	1,753	1,442	1,553
Final weight per pig....do....	191.7	193.6	198.4	194.8	206	194.2
Gain of lot.....do....	1,018	1,010	1,066	1,021	658	1,053
Gain per pig.....do....	145.4	144.3	133.2	113.4	94	131.6
Gain per pig per day....do....	1.35	1.54	1.46	1.47	1.68	1.45
Grain consumed in feed lot, pounds	4,608	4,329	4,520	4,570	2,767	4,662
Hay consumed.....tons..	201	174	170	166	150	189
Grain fed per pound of gain, pounds	4.53	4.29	4.24	4.48	4.21	4.43
Profit per lot (grain at $3.25, hay at $12, hogs at $15)	$1.73	$9.77	$11.98	$3.63	$7.87	$5.30
Profit per hog	.25	1.40	1.50	.40	1.12	.66

[a] One pig died on November 4 and is figured out from the beginning of the dry-lot feeding period. The trouble was thought to be blind staggers or apoplexy.

It required from 56 to 108 days to finish the lots after they were removed from pasture. Lot 2, formerly on a 1 per cent grain ration, finished almost as quickly as did lots 3 and 6, which had been on a 2 per cent corn and barley ration, respectively. This may be partially credited to the gains of one individual of that lot. This pig's gain was rather phenomenal throughout the period. Lot 1, which had been carried on no grain, made less daily gains throughout the period, and at the end of the experiment these pigs at 192 pounds were very fat but were very short and had small frames. Lot 5 made the highest daily gains while in the dry lot and also made gains on less grain than the other lots, while lot 1 required more grain per pound of gain than any other lot. Lot 3, which had been carried

on a 2 per cent corn ration, returned a greater profit than any other lot. It may be possible that some of the smaller pigs of lot 1 had been slightly stunted while being carried on no grain. The combined results of summer pasturing and dry-lot feeding are shown in Table XXII.

TABLE XXII.—*Results of summer pasturing combined with different grain rations during the finishing period in a dry lot upon six lots of pigs on the Huntley Experiment Farm in 1917.*

Item.	Lot 1.	Lot 2.	Lot 3.	Lot 4.	Lot 5.	Lot 6.
Area of pasture lot.....acres..	0.50	0.25	0.25	0.25	0.25	0.25
Number of pigs in lot.....	7	7	8	9	7	8
Period on pasture.....days..	84	84	84	84	84	84
Period in feed lot.....do....	108	94	91	77	56	91
Total time.....do....	192	178	175	161	140	175
Initial weight of lot on July 11, pounds.....	243	237	282	311	283	278
Initial weight per pig.pounds..	34.7	33.9	35.2	34.6	35.4	34.7
Final weight of lot.....do....	1,342	1,355	1,587	1,753	1,442	1,553
Final weight per pig....do....	191.7	193.6	198.4	194.8	206	194.2
Total gain of lot.....do....	1,099	1,118	1,305	1,442	1,159	1,275
Total grain consumed...do....	4,608	4,581	5,209	5,872	4,639	5,316
Total hay or hay equivalent, tons.....	2.09	.91	.71	.85	.91	.88
Grain fed per pound of gain, pounds.....	4.19	4.10	3.99	4.07	4.00	4.17
Profit per lot (grain at $3.25, hay at $12, and hogs at $15)..	−$9.99	$7.90	$17.46	$15.26	$12.16	$7.92
Profit per pig.....	− 1.43	1.13	2.18	1.70	1.74	.99
Returns per ton of hay.....	7.22	20.68	35.28	29.94	25.36	21.00

Lot 1, which had been carried for 84 days on alfalfa pasture alone, showed a loss of $1.43 per pig when feeds and gains were figured at a fair market price, while all other lots showed a profit ranging from 99 cents to $2.18 per head. Lot 5, which in the spring period showed the greatest profits, was second in profit. It returned a profit of 44 cents per pig less than lot 3, but was kept on feed 35 days less. These results indicate that when pigs weighing 35 or 40 pounds are turned on alfalfa pasture it may be economical to feed not more than 2 pounds of grain daily per 100 pounds weight, but that it is not at all advisable to try to carry them on alfalfa pasture alone.

Approved:
WM. A. TAYLOR,
Chief of Bureau.

MAY 25, 1918.

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